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Laryngology.

STRICTURE OF THE LARYNX.

CLINICAL LECTURE DELIVERED AT THE JEFFERSON MEDICAL COLLEGE.

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GENTLEMEN,—As the principal subject-matter for to-day I will present to you a case as an object-lesson from which you will be taught some very important practical points not detailed in your ordinary text-books nor discussed in your didactic lectures. You will notice that this boy, a well-nourished lad, thirteen years of age, wears a handkerchief around his throat, and that he has a whispering voice. You will also note that the voice is a laryngeal whisper and not an oral one. You should always notice the difference between these two forms of whispers. An oral whisper indicates that the vocal bands are not in action at all. A laryngeal whisper indicates that there is some obstruction preventing approximation of the vocal bands.

One of you will be good enough to remove the handkerchief from the neck of the lad, and it at once becomes evident that it has been worn to hide something. This something is a silver tube which projects from within the trachea. You will note also, please, that the orifice of the tube is plugged with a cork. Nevertheless, the lad breathes freely without any impediment. A tube in the trachea, and yet the fact that the patient breathes through his nose despite occlusion of the tube, shows that he gets enough air alongside of the tube in the trachea, without having to depend upon his breathing through the tube at all. Here is an important point to bear in mind,—the size of the tracheal tube. It should be as large as is compatible with perfect freedom of movement in the trachea. You should never use a tube large enough to fill up the entire calibre of the trachea, as you may cause ulceration from pressure. You must not use one so loose that the lower orifice shall press anywhere on the wall of the trachea. Cases are on record of fatal results from ulcerations of the walls of the trachea and penetration into blood-vessels.

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(Internat. Clin., Phila.,
1891, 2.)

When the patient wearing the tracheal canula desires to use his voice, it is usually necessary to occlude the exterior of the canula with the finger or with some automatic contrivance, in order to prevent escape of the expiratory current of air during phonation, and to deflect that current upon the vocal apparatus. It sometimes happens, however, as I showed in a few instances to my classes in this college years ago when I was more actively associated in its teachings, that a tracheotomized patient has such a copious volume of air that he can speak satisfactorily without occluding the orifice of his canula at all. When tubes are used which fill the trachea, it becomes necessary to have the upper portion of the canula perforated, in order that the air from the lungs shall reach the vocal apparatus, to enable the patient to use his voice. When the canula does not occlude the calibre of the trachea, a sufficient volume of air will pass by the sides of the canula to set the vocal bands into phonal vibration. Nevertheless, it has become very common for surgical-instrument makers to make an opening—a fenestra, as it is technically called—in the tracheotomy canula. I pass a number of such fenestrated canulas around: some of silver, some of aluminium, some of other metals, some of vulcanized rubber.

You will notice that the fenestræ are in the horizontal portion of the tubes. Now, nine times out of ten these fenestræ are made so far forward towards the exterior extremity of the tubes that they will not be in the trachea at all when the tubes are in position, but will be located in the track of the wound exterior to the trachea, where their presence will produce excessive granulations. When a little farther back, excessive granulations are produced at the edges of the tracheal incision which straddles them. The granulations may dip down into the lumen of the canula, and not only obstruct the breathing of the patient, but seriously interfere with the withdrawal of the canula for purposes of cleanliness.

In order to fix your attention prominently upon this very important and insufficiently appreciated point, I will relate to you an instance which occurred in a case of mine which has become historical,—not for the intrinsically important features of the case itself, so much as to illustrate the fact that serious injury may be produced by these fenestra. It is my case of epithelioma of the larynx alluded to by Professor von Bergmann in his account of the fatal case of the late German Emperor Frederick, upon whom he desired to perform the same operation at the time the case was taken out of his hands, having successfully performed it upon another patient three years previously.

About twenty-four years ago I opened the larynx of a gentleman

and removed an epithelioma therefrom in the presence of a distinguished galaxy of surgeons, including the two late Professors Gross and the elder Pancoast of this college, Professor Jones of Chicago, the late Professor R. J. Levis, at one time of this college, the late Professor Elsberg of the University of New York, Professor Agnew of the University of Pennsylvania, Professor Brinton of this college, and the late eminent surgeon Dr. John L. Atlee of Lancaster, the patient's physician. After I had operated on that patient,—who, let me state, is still living, and has visited me at my office only a day or two ago,—he continued to wear a tracheotomy-tube which I had placed in his trachea a short time before the thyrotomy and the extirpation of the neoplasm. I told him that he would have to wear that tube from six to eighteen months, in order that any recurrence of morbid growth could be readily attacked from above or from below, as might be, without splitting his larynx open a second time.

In the mean time we looked after his general health, which had become somewhat impaired by the severe measures to which he had been subjected, and advised him to travel a while in Europe. I gave him a list of surgeons in the medical centres of Europe, to whom he might apply should he need their services, and to one or other of whom he should submit his larynx for inspection at intervals of a month or so to determine the presence or absence of recurrent growth as might be. But I especially warned him not to let any of them persuade him to have his tube removed, and not to let any of them put in a fenestrated tube, as I knew they would be likely to do, for I felt certain that if they did so he would have trouble with it. Nevertheless, in Paris he was induced to have his tube taken out and a fenestrated one inserted in its stead. As predicted, exuberant granulations grew, and finally projected into his tube. One day, being unable to withdraw his canula, the man was nearly suffocated, and sent hurriedly for his physician, who had to tear the tube away bodily, cauterize the surfaces of proliferation, and replace my tube. The patient was confined to his hotel for some weeks in great pain, distress, and peril; and finally returned to Philadelphia in safety with the same tube that had been inserted before he left. After the prescribed period had elapsed, I took the tube out, and he has not had occasion for its reintroduction, nor has he had any recurrence of morbid growth.

I call your attention to this to show you that there is no necessity for fenestræ in tracheotomy-tubes. Another point: where the patient has to wear a tracheotomy-tube for a number of years, as the patient before you has had to do, and even after ordinary operations for croup,

it is always best to have two tubes. One should always be clean. They should be changed on alternate days. One should be a little shorter than the other, so as to vary the points of any pressure on the trachea or on the track of the wound. In certain classes of individuals you will find that the patients not only neglect to change their tubes, but that they keep them in a long time without even cleaning them; and in this way more or less corrosive destruction of the tubes necessarily takes place, exposing the patient to dangers from direct injury to the tissues by the jagged edges of the tube, or to its separation from its collar and its escape into the trachea as a foreign body.

The ideal tube should be made out of one solid piece of metal, and best of silver. I have sometimes used leaden tubes made in this way, such as you see here, for the first few days after an operation; and I believe that the presence of the lead acts favorably upon the track of the wound. Usually, however, these metallic tubes are made of rolled plates, jointed and soldered. Wherever the tubes are soldered there are two metals in contact, one in the tube itself, the other in the solder. Wherever two metals in contact are immersed in a saline solution, there an electro-chemical decomposition is set up. Now, the secretions which accumulate around the tubes are alkaline, and so at the two points where the two metals are joined all the essentials for electro-chemical decomposition are present. Hence there is corrosion of the tubes from galvanic action. I pass around for your inspection a number of tubes thus corroded; all are in a dangerous condition, some of them very precarious. Not only are the rough edges of the metal apt to produce ulceration, but after a while the tube may separate from its shield and drop down into the trachea. I have had several cases of this kind where the tubes got loose and dropped down into the trachea, and simply because the patients were too careless to take care of them. I have known patients to wear the same tubes seven years or more, and never take them out to clean them. Of course there is not so much danger to the patient's life on account of the tube dropping into the windpipe as there would be from most other foreign bodies, because it is of such a shape that the patient can breathe through it. It can, too, usually be easily lifted out by running through it a thick copper wire the end of which has been bent into a blunt hook to catch around its distal extremity.

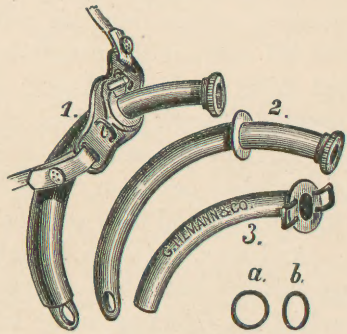
Another point to which I would call attention is the superiority of silver, or metallic tubes generally, over hard rubber tubes. The reasons why you should use metal and not hard rubber tubes are: First, because the hard rubber breaks easily and the tube may escape

into the trachea; secondly, because it takes up more room: it is thicker, and thus cuts off the patient's breathing-space to a greater extent than a thinner metallic tube. The most important point, however, is this: a silver tube becomes tarnished by the secretions. If any necrosis of tissues occurs around the tube in the track of the wound or in the trachea, as is so frequent after tracheotomy, especially in cases of croup or diphtheria, it soils the silver tube and does not soil the rubber tube. Hence, when you take out the metal tube and see a black or a discolored spot upon it, you are made aware of the danger; and you can then relieve the pressure to which it is most likely due by putting a compress under the collar or shield of the tube, above or below as may be required.

Another point of minor importance to which I desire to call your attention is a very neat way of having your tapes attached to the collar of the tube with buttons and button-holes, instead of having them sewed on. (See Fig. 1.) Then, when you want to change the tapes, on account of being soiled with blood or with other products, you do not have to pull the tube out and leave it out for a time while new tapes are being sewed to the collar. You just unbutton one side, and replace it with a new tape; and then repeat the procedure on the other side. Always have one tape shorter than the other, so that you can fasten the knot on one side of the neck, and not be compelled to raise the patient's head to unloosen the tube or take it off, as you have to do when the tapes are of equal length and are fastened behind. You will note, too, that these tubes are provided with a catheter-shaped guide to facilitate introduction without stretching the lips of the incision.

There is, in the case of tracheotomized subjects, a point of physiological interest to which I wish to call your attention. You are aware that the air inspired into the lungs receives heat and moisture in its passage through the nose. Some physiologists and some laryngologists contend that the air thus breathed becomes thoroughly saturated with moisture in the nasal passages, and is therefore incapable of receiving

FIG. 1.



TRACHEOTOMY TUBES FOR ADULT (one-half measurement).—1, tube with pilot, and tapes secured with buttons ready for insertion; 2, perforated pilot; 3, inner tube; *a*, section of lumen of tracheal extremity of inner tube: circular; *b*, section of lumen of tracheal extremity of inner tube: oval.

any more moisture from the lungs. They infer from this that our notions are wrong that any of the halitus of the expired breath, which we know will condense upon a polished surface, is due to saturation of the air from the lungs. While experiments with glass tubes upon the normal subject may confirm this inference, clinical observation on the tracheotomized patient does not support the opinion. The air expired from the canula of a tracheotomized subject with complete occlusion above the artificial orifice will sully a polished surface and condense in the atmosphere on a cold day, just as will the breath from the nostrils of the normal subject. A tracheotomized patient of mine, with practical occlusion of the glottis, who could not bear his canula to be stopped up even for a minute, was very much annoyed in winter-time by having people come up to him and tell him that his collar or neck-cloth was on fire. He wore a cloth over his canula, and the expiratory current of air escaped above it. The stream of condensed moisture issuing from his neck behind his collar looked like smoke, and led some of the passers-by to imagine that a spark from a cigar had fallen on his neck-gear and had set it on fire. While the air breathed through a tracheal canula becomes heated by the warmth of the garment the patient may wear over his tube, its moisture in cases of complete occlusion must certainly be derived entirely from the tracheo-bronchial tract and the pulmonary spaces.

And now, as to the history of the case before you. Eight years ago this boy had croup or diphtheria in Denver, Colorado, followed by multiple papillomata in the larynx, for which Professor Davis, in the college there, performed tracheotomy when the lad was almost in the agonies of death. In consequence of inflammatory action, papillomata developed here in the larynx, as they often do after measles, croup, and diphtheria, and sometimes after whooping-cough. I know of no more frequent cause of papilloma in the child than the inflammation in the larynx accompanying measles. The physicians were unable to remove the papillomata through the mouth, on account of the youth of the patient, and Dr. Davis then split the larynx and removed the growth. Recurrence ensued, and two years later Dr. Davis kindly sent the patient to me. I sent him to the German Hospital for operation. Recognizing my inability to remove the morbid growths through the mouth, I split the larynx open a second time and removed the growths thoroughly by direct access. Although we did not practise antisepsis then as now, the reaction was so slight that the next day, when I had just repeated a similar operation on an adult, this child was found standing by in his night-dress to see what the doctor had done

to him the day before. He got perfectly well. A few weeks afterwards, on account of a recurrence of these growths, I split open the larynx a third time. A few months afterwards I was compelled to open the trachea below the tube and remove some growths there. I think I performed the last of these operations some six years ago. Since then there has been no occasion for a major operation; but there has been a great disposition to repullulations in the parts originally implicated, and I have taken out several masses through the mouth upon various occasions and at varying intervals. The result of these repeated proliferations of tissue and removal by evulsion and by electric cauterization has been to produce an irregular stricture of the larynx at the glottis, so that the lad has been compelled to wear his tracheotomy-tube as a permanent fixture. I made repeated attempts at dilating this stricture as opportunities presented in the very irregular intervals of the patient's attendance, but without much progress. The methods pursued will be described to you a little later, in connection with some general observations on the treatment of stricture of the larynx.

Some two years ago I thought I would attempt to relieve the boy of his tube, and sent him to the Children's Hospital and put in an intubation-tube, which he wore for several weeks. I did not see that it did any good. After removing the tube I thought the parts were more constricted and the passage for air smaller, and I replaced the tracheotomy-tube. Shortly afterwards I removed the tracheotomy-tube and had the child carefully watched, thinking perhaps he might be able to do without it; but a few days later he was brought to my office in the arms of a nurse, black in the face and unconscious,—in fact, almost asphyxiated. I seized an ordinary trocar and canula that was lying on my table and plunged it into the trachea at the seat of the original orifice, withdrew the trocar and left in the canula; and a few minutes later, after respiration had become re-established, I enlarged the wound and put in a tracheotomy-tube. He has worn a tracheotomy-tube ever since, though not the same tube all the time. I determined to defer further efforts at relief until the period of puberty should be reached, and which is now approaching.

For the last few months the boy has been able to breathe with the orifice of the tube closed with a cork. And now I propose to have him stay in this hospital a while where he can be watched, while we make another attempt to see whether he can do without the tube.

You know that after puberty the larynx in the male grows very rapidly. Before that period the larynx of the male and that of the

female are much the same, and the voices are very much the same; but as the boy grows to manhood his voice gets deeper and more sonorous, and he accordingly becomes able to take in a larger volume of air.

This case, then, is one of stricture of the larynx, the result of repeated operations for the removal of multiple growths near the glottis; a stricture which has long restricted the breathing-capacity of the patient. But now, as you see, the patient breathes with the tube occluded by a stopper, and I think that he may be able to breathe without it. I do not intend to withdraw the tube and then close the exterior orifice at once. That would not be prudent. I have provided here a plug to place in the track of the wound, so that it will not close up after I have removed the tracheotomy-tube. It is cylindrical as far as it goes into the track of the wound. Beyond that point it is merely a thick wire with a bulbous extremity to facilitate its introduction. There is rarely any occasion to freshen the edges of a tracheal fistula of this kind to make it close. Closure is often complete after a few hours; almost invariably after a few days. Sometimes the outer opening will close almost immediately after removing the tube. In the very case which I detailed to you in exemplification of the uselessness and danger of a fenestrated tube, the orifice closed so tightly within ten minutes on one occasion that I was compelled to administer chloroform and enlarge it by incision so as to reintroduce the tube. It was this occurrence that taught me always to have a clean tube ready to replace the one withdrawn. The plug prevents this constriction of the orifice

FIG. 2.



Apparently cured stricture of larynx; extreme inspiration. (After protracted treatment by dilatation.)

by filling up the track of the tracheotomy-wound just as the tracheotomy-tube does, and the slender wire in the trachea itself does not interfere with the breathing. Two tapes are tied to it, as to the plate of the tracheotomy-tube, so as to secure it around the neck. Thus protected, the fistula remains patent, and the resident physician can put in a tracheotomy-tube if necessary, in case the boy cannot breathe without it.

This boy has a deformed glottis (Fig. 2), and the vocal band on the left side is adherent to the ventricular band above it, and does not move in phonation, but remains in the middle line. That is why the boy has this peculiar voice. The constriction prevents the vocal bands from coming together, and there is no truly vocal sound. Besides this, the larynx is a very small one. Under ordinary circumstances I would not trust it, for,

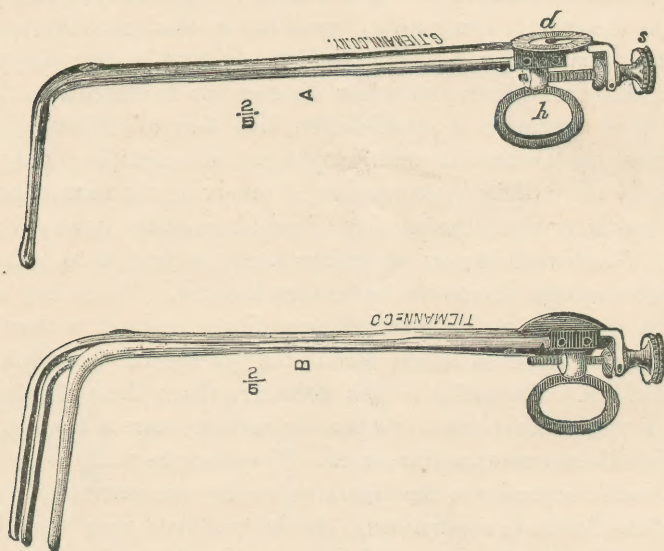
when a larynx is constricted by chronic disease, it takes but little acute inflammation to close it entirely. But, as the lad has become accustomed to his constricted glottis, he may probably be able to continue to breathe through it. It may even become dilated under the influence of the compressing and somewhat forcible inspiratory current of respiration. We find, too, in chronic disease, that the larynx gradually becomes accustomed to gradually increasing stenosis, so that the patient can live comfortably with a breathing-passage so small that it would be certain to produce suffocation were the occlusion to occur suddenly as the result of accident or of acute disease. In chronic diseases, therefore, we do not run the risk in trusting to a constricted orifice that we would run in acute disease.

And now, gentlemen, a few remarks upon the general treatment of stricture of the larynx, which is essentially the same, as far as the mechanical features are concerned, no matter what the cause of the stricture. It is caused by inflammation and infiltration of the tissues and the concentric cicatrization of breaches of continuity. It may be due, as in the case before you, to recurrent morbid growths and the operative procedures for their eradication. It may be due to syphilis, to tuberculosis, to lupus, and other diseases, or to surgical or other injury. The treatment is by dilalation, like that of stricture in any other passage,—the urethra and œsophagus, for example; only it is considerably more difficult, on account of involving the narrow portion of the respiratory tract, the patency of which must be preserved at all hazards. Graduated dilators of various kinds, so bent as to be readily introduced through the mouth, have been devised. When they are to remain in the passages more than a very few seconds at a time, they should be perforated so as to permit the passage of the respiratory currents of air. Especially is this necessary when the patient is not wearing a tracheotomy-tube. When the patient wears a tracheotomy-tube, solid dilators are sometimes used. They may be retained for hours at a time with impunity to the breathing, as they are inserted above the orifice of the fistula in the trachea. As the treatment progresses, larger and larger dilators are used, until the normal calibre of the narrowest portion of the laryngeal cavity has been attained, or until it becomes evident that no further dilatation is practicable. If the calibre of the constriction becomes sufficient for respiratory purposes, the tracheotomy-tube is withdrawn under precautions somewhat like those that have just been shown you. Treatment by gradual dilatation is a very protracted procedure. If you ever attempt it, be frank enough to your patient to state that it will take a period varying from six to

eighteen months to accomplish any permanently satisfactory result. Your experience will then be like mine. You will lose a number of patients who will waste time in attendance upon practitioners who give them more encouragement; but you will have the satisfaction of curing most of the few who do remain under your care, while your percentages of successful results will be better. I have succeeded in permanently curing several desperate cases of stricture of the larynx.

And now let me give you one important piece of advice in commencing this treatment. Remember that you have a concentric constriction, more or less irregular of course in the majority of cases, but practically concentric and retractile. You can stretch it with suitable contrivances, but when you relax the stretching force the constriction will recur, and may even become greater than when you began, as it did in this boy, who wore an intubation-tube with perfect safety for several weeks. I should, therefore, recommend you to nick the stric-

FIG. 3.



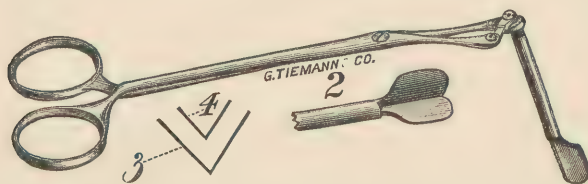
MACKENZIE'S DILATOR (two-fifths measurement).—A (closed).—h, ring-handle; d, dial-plate; s, dilating screw. B, open.

ture with an exposed or guarded knife, as may be, at one or more of the most constricted portions, before you leave any dilator in the stricture for therapeutic purposes. In this way you enlarge the stricture before you dilate. Then with some special dilating contrivance you may stretch the stricture, and will be able to insert a much larger

dilator than otherwise. When the fresh wounds cicatrize around this dilator, you will probably have gained a little, after a while a little more in the same manner, and so on. The permanent pressure of the dilator, too, promotes absorption of resorbable effused products in the constricting tissues, and thus tends to enlarge the constricted portion of the passage permanently.

I show you a number of instruments, machines we might call them, devised to dilate a stricture of the larynx. They may be used to tear a stricture apart at some points by divulsion, but this use I do not recommend. One of the most ingenious is this device of Sir Morell Mackenzie (Fig. 3). It consists, as you see, of a three-bladed instrument with the laryngeal curve, the terminal or intralaryngeal portions of which are separable by turning a screw at the proximal extremity. Attached to this screw is a dial-plate so graduated as to indicate the calibre reached by the blades at the other end. Several other instruments of this kind have been devised by other practitioners. Mackenzie's is the best, because the blades separate in such a way as to represent the normal shape of the distended glottis. But they all have

FIG. 4.



COHEN'S DILATOR.—2, blades open; 3, anterior; 4, posterior surface of open blades.

the objection that the pressure is made only at certain points. It is not always the case that dilating force at these points will rupture a stricture or even dilate one that has been previously nicked. I far prefer an instrument devised by myself some sixteen or eighteen years ago, and then used for the first time upon a gentleman from Zacatecas, Mexico, sent me for the purpose by an old friend, Dr. Prevost, of that city. It is composed, as you see (Fig. 4), of two flat rectangular blades which by scissors-movement at the handle are made to move upon a hinge anteriorly, so that when opened they represent precisely the triangular shape of the distended glottis, while they press upon the entire surface of the two sides of the triangle; the same sides pressed upon by one point only in Mackenzie's instrument and other instruments of that class. In this instrument the pressure is uniform, dilatation is more systematic, regular, and effective, and is less injurious upon the

parts pressed upon. I have seen no instrument devised since which appears to me equal to it.

The stricture having been nicked and dilated, the procedure may be repeated at intervals to prevent reconstriction. The instrument I have just shown you was used daily, or almost daily, by the patient himself for a prolonged period. A better method, however, is to follow each nicking and stretching by the introduction of catheter-like perforated dilators of the configuration of the glottis, such as I show you here, and which are the device of Professor von Schrötter, of Vienna (Fig. 5). It was by the use of these dilators that we have been able to overcome the stricture in the case before you. Here are a series of such tubes made of hard or vulcanized rubber, and graduated from the smallest to the largest size; and in connection with them here are a series of solid pewter plugs, externally of the configuration of the glottis, which are intended to replace the tubes for hours or days

FIG. 5.



SCHRÖTTER'S PERFORATED DILATOR.—A, extension tube to direct products of cough downward; B, external extremity of dilator; C, body of dilator; D, catheter-like inner extremity.

at a time in cases of stricture in which a tracheotomy-tube is in use. The method of treatment is essentially as follows: As large a dilator as practicable is introduced and allowed to remain, according to the patient's tolerance, from five minutes to half an hour or longer. It is then removed, and a dilator of the next larger size is immediately introduced and withdrawn a few seconds or a few minutes later. If the patient is wearing a tracheotomy-tube, the corresponding size of solid plug is introduced into the larynx and allowed to remain a number of hours or a day or longer as may be. These plugs, as you see, are three-cornered cylindroids with rods running through them. The upper portion of the rod is perforated so as to carry a string by means of which the plug can be withdrawn. The lower portion of the rod is knobbed so as to be seized in the grasp of a pair of forceps, which is introduced into the tracheal canula through a large fenestrum in which the lower end of the plug penetrates a short distance. Latterly Schrötter has abandoned the knob, and has simply obliquely

perforated the lower extremity of the plug itself, which he fastens in position with a bolt which takes the place of the ordinary inner canula and is constructed practically in the same form. When the plug is to be removed, the bolt is drawn out, and a pull is made on the string which projects from the mouth. Introduction of the plug requires the use of a specially contrived conductor which clasps the upper end of the rod in the plug, and from which it is withdrawn by a tug when the plug has been placed in position.

Introduction of the plugs requires the services of the physician ; but treatment by dilatation with the tubes only is sometimes confided to the patient, who often learns to introduce them much more deftly than the physician can.

The frequency of these manipulations will, of course, depend upon conditions which vary in individual instances and concerning which you must depend upon your individual judgment.

The patient should be taught to introduce the tubes himself, and should be instructed to repeat the process at intervals after withdrawing from professional care, on the same principles with which you give analogous instructions to a patient who has been under your care for stricture of the urethra.

[The patient—seven weeks later—is still breathing comfortably without his canula, and is attending school.]

